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Art. IV.—*Victorian Graptolite Zones, with Correlations and Description of Species.*

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(With Plates III-VI.)

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I.—History of Research.

More than two decades have elapsed since the publication of any notable paper on the general classification of Victorian graptolites. Indeed, only two such papers occur to mind, both by the late Dr. T. S. Hall (6 and 7).

At the conclusion of his life's work on Australian graptolites he (9) summed up the state of knowledge as follows:—"Large collections made by the Survey (Geological Survey of Victoria) have somewhat extended our knowledge of the fauna and its distribution but without adding any features of importance." At the time when this rather pessimistic summary of the position was made, the study of Victorian graptolites was about to enter on a new phase of expansion, revealing many "new features of importance." This expansion owes much to the sympathetic and methodical encouragement of the Director of the Survey, Mr. W. Baragwanath, himself the pioneer in the exploration of an interesting but rugged Upper Ordovician and Silurian area near Walhalla. Under Mr. Baragwanath's judicious guidance, the officers of the Survey have examined many important areas of Palaeozoic rocks with an intelligent appreciation of the value of palaeontological evidence, and the present writers have not only had the advantage of examining collections from widely separated districts, but have been able to test their evidence in the field. Some of the more important developments since 1914 may be summarized as follows:—

(a) The detailed work of Keble on collections from the Bendigo district and his field work in the Mornington Peninsula have made possible the zoning of the Lancefield and Bendigo series.

(b) The field work of Harris (12) in the area east of Castlemaine showed the existence of previously unrecognised beds between the Castlemaine and Darriwil series as known to Hall, and enabled the Darriwil beds to be zoned.

(c) Harris and Crawford (4) discovered near Romsey a *Staurograptus-Dictyonema* bed, marking a lower Lancefield horizon than had before been recognised in Victoria. They also checked the Darriwil succession in the Gisborne district, demon-

strated the improbability of any considerable break in the sedimentation between Lower and Upper Ordovician, and suggested outlines of Upper Ordovician zones.

(d) A. T. Woodward discovered at Bendigo East graptolites which on examination proved to belong to the Upper Darriwil, and already recognised at Gisborne by Harris and Crawford (13), at Mornington by Keble, and since found among earlier collections made by O. A. L. Whitelaw from the Enoch's Point Lower Ordovician inlier in the Upper Goulburn basin. Field work at Bendigo East by J. C. Caldwell, of the Survey, and Harris, showed these beds to be more extensively developed there than elsewhere, and they have since been recognised near Romsey by D. E. Thomas, and along the Gibbo River, north of Omeo, by Harris and Thomas.

(e) A minor but interesting discovery was made of Bendigo forms at Boolarra in Gippsland by W. H. Ferguson (4), far east of the better known Lower Ordovician belt of Central Victoria.

(f) In the Walhalla-Aberfeldy district, W. Baragwanath, Trentham district, H. Foster, Axedale district, J. C. Caldwell, Bendigo district, the Bendigo Underground Survey Staff, and Keilor-Lancefield district, D. E. Thomas have made known large areas of graptolite shale. Their efforts constitute a noteworthy continuation of the earlier work of W. H. Ferguson, formerly of the Victorian Geological Survey, and the pioneer efforts of A. R. C. Selwyn, N. Taylor, R. Daintree, C. S. Wilkinson, C. D. Aplin, Sir Frederick McCoy and others of the early Victorian Geological Survey onwards from 1850.

(g) In many instances our identification and descriptive work has not been published, or is included in publications on general geology dealing with a district. A complete list of the unpublished work is far too comprehensive to be listed here.

(h) Much time has been devoted to the study of the Upper Ordovician and Silurian beds, and though a tentative zoning is now possible the paucity of continuous sections makes the task of checking this difficult. Work at present being carried on by Thomas under the direction of the Geological Survey in the Keilor-Lancefield area will yield important results in this connection.

Dr. Hall in 1894 (5) placed the Victorian graptolite series in the ascending order, Lancefield, Bendigo, Castlemaine, zoned the Castlemaine series and correlated the Darriwil beds as then known with the Upper Castlemaine. In 1899 (6) he elaborated his serial zoning. The Lancefield series was based on the famous "Lancefield Quarry" outcrop north of the old Mount William station on the disused and now dismantled Lancefield-Kilmore railway line. For Bendigo beds more widely spread localities were referred to, but in Dr. Hall's opinion "no salient differences have been noted between the faunas of the different exposures." The association of *Tetragraptus approximatus* with Lancefield forms at Ingle-

wood and with Bendigo forms on the Mornington Peninsula later enabled Dr. Hall to suggest the line of demarcation between the Lancefield and Bendigo series (8). The detailed zoning of the Castlemaine series has stood the test of later work by T. S. Hart (15) at Daylesford, and Harris (12) in the type area at Castlemaine. The Darriwil beds were known to Dr. Hall (11) only from one locality in the parish of Darriwil, until in 1913 (6) he examined a large suite of graptolites from the Steiglitz district collected by W. H. Ferguson. A large number of his determinations of the Steiglitz graptolites have not been published. He here made his first acquaintance with what we may call the previously unknown zones of the Darriwil, but not having any opportunity for field work, was quite at sea. He placed some of the Darriwil beds among the Lower Castlemaine zones, and though he placed others correctly in the Darriwil, he relegated them to a position too low in that series.

Before dealing with each series and its zones in detail attention may well be called to a point which is of importance in all attempts at zoning, and which has been well expressed by Dr. Elles (3). That experienced graptolithologist from her extended study of British graptolite zones writes: "Some commingling at the boundaries of the zones must naturally be expected, especially when dealing with a succession of purely shaly deposits, but as a rule even then *the coming in of new forms in abundance* should be taken as an index of the passage to a higher horizon. This fact is one upon which great emphasis should be laid; it is upon this, *the coming in of new forms*, usually indicative of a more advanced stage in evolution, that the basis of modern zonal stratigraphy is laid; the persistence of old forms tends to vary greatly in different localities. There does not appear to be any justification for action which results from focussing too much attention upon the index fossil rather than upon the *assemblage*, which is the determining factor."

This advice is necessary in considering zonal tables. Such tables must be at the best tentative. Many zonal differences, when set down in words, appear trifling, whether a bed is L2 or L3, for example, and it is only by extended field work that one is able to weigh all the evidence. Even in the field it may be difficult to say in exactly what the differences consist, and when one has to decide, Miss Elles' dictum that "it is the assemblage which is the determining factor" comes with added force. The tables which follow should be read with this in view, and not regarded as a royal road to the determination of graptolite zones.

II.—Victorian Graptolite Series.

At the outset it may be stated that Dr. T. S. Hall's serial order, Darriwil, Castlemaine, Bendigo and Lancefield, still stands. It is now possible to zone each of these series, and for this purpose we

have adopted the initial letters D, C, B, and L, with a numeral to indicate the zone, zone 1 being the highest in each series. To conform to the accepted practice we would have preferred to number the zones in the reverse order, but the system used is that introduced by Dr. Hall, and has been in use for so long that a change now would lead to endless confusion.

It should be stated that ordinary stratigraphical methods have amply demonstrated the accuracy of this zonal subdivision, and on the other hand, the zonal subdivision has either corroborated or elucidated the stratigraphy. The main purpose of this contribution is to place in the hands of the field geologist a simple means of checking his work; elaboration tending to complicate is to be deprecated. For this reason we have refrained from referring to those still finer subdivisions used by us where close differentiation is asked for, and we take this opportunity of warning future workers on the Victorian succession against multiple subdivision, unless it has been established by ample field evidence over a wide area.

(A.) Darriwil Zones.

Although the Darriwil series is less known than any of the others, since Harris outlined it (12) in 1916, our knowledge of it has been extended considerably. The absence of mining and consequent lack of exposures, the abnormal development of shales which are difficult to differentiate, the graptolite assemblages which elsewhere have no equivalents, are problems confronting the stratigrapher and palaeontologist. In it the characteristic Lower Ordovician *Axonolipa* give place to the Upper Ordovician *Axonophora,* consequently there are a number of specialised and unique forms which do not conform with accepted genera, and which necessitate the formation of new genera, often monotypic.

It has been already stated that Dr. Hall's "Darriwil Beds" form but a small part, a portion of the uppermost beds, of the Darriwil series as recognised at the present time. The lowest zone, D5, is characterised by the occurrence of *O. upsilon,* which is rare in C1, the Castlemaine zone below it. Zone D5 may be called the *Oncograptus* zone, though the genus ranges rather indefinitely higher, being then associated with the allied genus *Cardiograptus.* The zone is also separated from C1 by the appearance of *Trigonograptus* and *Didymograptus v-deflexus,* while *D. caduceus* is still common, but is usually represented by variant forms, var. *manubriatus,* and *D. forcipiformis.* In D4, *Cardiograptus* is associated with *Oncograptus,* otherwise the facies is much the same.

At Castlemaine and Gisborne, *Cardiograptus* occurs without *Oncograptus,* and this characterises the zone D3. At Lancefield, however, D. E. Thomas has recently discovered a bed in which *Oncograptus* occurs without *Cardiograptus* in the typical assem-

blage of zone D2. It will be interesting to see whether *Oncograptus* is recessive or whether there are morphological differences sufficient to separate its higher from its lower forms.

After the disappearance of *Cardiograptus morsus,* beds are found characterised by the abundance of a small *Diplograptus,* which has been identified by Dr. Hall as *D.* cf. *inutilis,* but which is here described as a new species under the specific name *Diplograptus austrodentatus.* This form crowds the D2 beds and other forms are relatively rare. These include the long-range species *Tetragraptus serra* and *Didymograptus caduceus,* and the typically high-ranging genera, *Trigonograptus, Glossograptus* and *Lasiograptus.* Lastly, we have D1, the highest Darriwil, a zone of unknown extent and of such great development and richness in graptolites that it is almost certain that it will ultimately be further divided. This zone is extensively developed east and southeast of Bendigo, where field and laboratory work by the authors and Mr. J. C. Caldwell, of the Geological Survey, is still proceeding. The fauna is so characteristic that it cannot be confused with those in the lower zones. Very typical, but not present in the same profusion at all outcrops, is *Didymograptus nodosus,* an aberrant form, the nearest relation to which among Old World species is probably *D. spinosus. Atopograptus woodwardi,* hard to recognise except when favourably preserved, is still more aberrant, combining a *Didymograptus* polypary with volute monograptid thecae. *Cardiograptus crawfordi* is a paracmic *Cardiograptus. Cryptograptus tricornis* is a forerunner of the Upper Ordovician, as are also the numerous *Diplograpti, Glossograpti,* and the occasional *Climacograpti. Lasiograptus* is common, *Trigonograptus* persists, while *Phyllograptus,* which is found sporadically from D5, is here represented by the well-marked species, *P. nobilis,* sp. nov., described later. Multiramous forms are not uncommon, one of the commonest being *Brachiograptus etaformis,* gen. et sp. nov., also described later, which is closely related to Bulman's *Loganograptus logani,* var. *boliviensis* (1), from South America. Another is a dichotomously branching, pendent species, reminiscent of a *Tetragraptus pendens*-like form, which has developed by several successive dichotomies. *D. caduceus* persists in a dwarfed form.

(B.) Castlemaine Zones.

The Castlemaine zones remain much as they were left by Dr. Hall, and need not be treated in great detail. The lowest zone, C5, still often referred to by Dr. Hall's term, the Wattle Gully beds, shows its position by the occurrence of *D. bifidus* without *Tetragraptus fruticosus.* Associated forms are numerous, most of them survivals from the Bendigo series. The only other form that need be noticed is *Didymograptus caduceus,* which here makes its first appearance, in some beds with the characteristic horseshoe polypary well shown although small, in others show-

ing only three or four thecae on each side of the characteristic sicular V. C4 is marked by the absence of *D. bifidus,* and, in general, a comparative poverty as regards species. *Phyllograptus* cf. *typus,* often large, is the commonest graptolite. C3, separated from the next lower bed by the comparative rareness of *Phyllograptus,* is still retained as a separate zone, though it is doubtful whether it is better entitled to zonal rank than certain other beds which have been merged. Like C4, it is usually poor in species and individuals, but at most outcrops *D. caduceus,* without any great increase of size, is the commonest fossil. In C2, Dr. Hall's Victoria Gully beds, *D. caduceus* is well on its way to maturity, and gives character to the zone. At most localities *Phyllograptus* is not found. Since, however, it occurs with Victoria Gully forms in one collection, and with C1 forms in New Zealand, it seems better not to exclude it from this zone. Continuing to flourish, *Didymograptus caduceus* is still the predominant fossil in the highest beds of the series, C1. It has here every indication of having reached its acmic stage, and the variations which mark particularly its progress and decline through the Darriwil series begin. *Loganograptus logani,* selected by Dr. Hall as characteristic of this zone, occurs also in C2, but is usually so rare as to be of little use as a zonal fossil. *Diplograptus,* which is common in some C2 beds, is also found in C1 and higher beds, but it does not give character to the zone.

(C.) Bendigo Zones.

The Bendigo series is the best known portion of the Lower Ordovician, and the Bendigo district provides typical outcrops of all its zones and finer subdivisions. The fauna is varied and readily differentiated, and by constant application of its finer divisions to economic problems, a high degree of precision has been attained in regard to the stratigraphical succession.

The broad subdivision is based on the advent and extinction of *Tetragraptus fruticosus,* and the zonal subdivisions mainly on the development of that species. *T. fruticosus (sensu lato)* commences as a 4-branched form in zone B5, reaches its acmic stage in zone B4, and paracmic stage in zone B3, where it disappears. By catagenesis a 3-branched form appears in zone B3, by rejuvenescence passes to its acmic stage in zone B2, to its paracmic stage, and thence on to extinction in zone B1. In zone B5 the 4-branched *T. fruticosus* is associated with *T. approximatus,* the zonal species of the Lancefield zone L1 next below it, and in zone B1 the 3-branched *T. fruticosus* is associated with *D. bifidus,* the zonal species of zone C5 next above it, so that the succession is essentially normal.

In zone B5 *Trichograptus fergusoni, Tetragraptus decipiens,* and *Didymograptus aureus* are survivals from the preceding zone; none of them range further than zone B5. In B4 the more typical

Bendigo fauna appears, and in zone B3 we have such forms as *Goniograptus thureaui, G. macer, Didymograptus extensus, D. dilatans, Tetragraptus serra, T. harti, T. similis,* and *Phyllograptus* spp.

In zone B2 *G. macer, T. harti, T. similis* and *Phyllograptus* spp. are common, and in zone B1 a very similar fauna occurs with the addition of *D. bifidus.*

(D.) Lancefield Zones.

For the present we designate as L5 a bed not yet found in Australia, but which from analogy with the northern hemisphere may be expected to occur—a zone which would be characterised by *Dictyonema sociale* or a vicarious form. It is confidently believed by us that when this zone is found in Australia the vicarious Dictyonemas will be those which occur with *Staurograptus* in the next higher zone, *D. scitulum* and *D. campanulatum.* The lowest zone with which we are at present acquainted is characterised by these two Dictyonemas, with *Staurograptus,* but apparently without any other species. This facies occurs north-east of Romsey, and is referred to L4. The next or L3 zone is that most familiar to students, the Lancefield Quarry beds. It is characterised by the absence of *Staurograptus* and the species of *Dictyonema* found in L4, and by the presence of *Dictyonema macgillivrayi, Tetragraptus decipiens, Bryograptus victoriae,* and *Clonograptus* spp., including *C. flexilis* and *C. tenellus.* The L2 zone is represented in the Lancefield district and elsewhere. *Bryograptus victoriae* persists from L3, and is perhaps the commonest species, though many of its associates from L3 also occur. *D. macgillivrayi* is rare or absent. *Tetragraptus approximatus* has not yet made its appearance.

The uppermost Lancefield zone, L1, is marked by the appearance of *T. approximatus,* the rarity of *Bryograptus,* and the absence of *Tetragraptus fruticosus,* the appearance of which in the next higher bed delimits the Bendigo series. The typical outcrop of this zone is on Bull Dog Creek in the Mornington Peninsula.

TABULATION OF ZONES.

DARRIWIL SERIES.

Zone	Typical Locality	Zonal Species	Associated Forms
D1	Bendigo East	Didymograptus nodosus Atopograptus woodwardi Brachiograptus etaformis	Cardiograptus crawfordi Climacograptus Didymograptus caduceus (rare) Phyllograptus nobilis Lasiograptus Glossograptus Diplograptus Cryptograptus tricornis Trigonograptus ensiformis Tetragraptus quadribrachiatus

Zone	Typical Locality	Zonal Species	Associated Forms
D2	Loc. 7SZ Geol. Surv. Vic. Sutherland's Creek Steiglitz	Diplograptus austrodentatus	D. caduceus Trigonograptus Glossograptus C. tricornis Tetragraptus
D3	Castlemaine-Maryborough Railway W. of Strangways	Cardiograptus morsus	D. caduceus D. v-deflexus Tetragraptus Phyllograptus Diplograptus gnomonicus Trigonograptus
D4	Chinamen's Creek Muckleford	Cardiograptus morsus Oncograptus	D. caduceus D. v-deflexus Trigonograptus Phyllograptus Tetragraptus Strophograptus trichomanes D. gnomonicus
D5	Castlemaine-Walmer Rd. E. of borough Boundary, Castlemaine	Oncograptus upsilon	Much as in D4 D. forcipiformis Goniograptus speciosus
	CASTLEMAINE SERIES.		
C1	McKenzie's Hill Castlemaine, water race in paddock N. of Castlemaine-Maldon Rd.	D. caduceus (maximum development)	Loganograptus logani Diplograptus sp. Didymograptus uniformis Tetragraptus quadribrachiatus
C2	Victoria Gully, Castlemaine	D. caduceus (sub-maximal development)	Diplograptus sp. Didymograptus spp. Dendroid forms Dichograptus cf. octonarius.
C3	Victoria Gully east of the Type locality of C2	D. caduceus (small forms) Phyllograptus cf. typus	Comparatively few.
C4	Burns Reef, Chewton	P. cf. typus. D. caduceus (small and rare)	Comparatively rare
C5	Wattle Gully, Chewton	D. bifidus	D. caduceus (small) Clonograptus spp. D. octobrachiatus Phyllograptus Goniograptus laxus G. crinitus Tetragraptus similis T. pendens
	BENDIGO SERIES.		
B1	Paddy's Gully, Bendigo	Tetragraptus fruticosus 3-br. D. bifidus	D. octobrachiatus Phyllograptus cf. typus Clonograptus abnormis Tetragraptus similis T. quadribrachiatus G. laxus G. macer

Zone	Typical Locality	Zonal Species	Associated Forms
B2	Napoleon Syncline - Bendigo	T. fruticosus 3-br.	Much as in B1 Didymograptus similis Goniograptus thureaui D. extensus
B3	Red, White and Blue Reef, Bendigo	T. fruticosus 3-br. & 4-br.	Didymograptus dilatans D. extensus Goniograptus thureaui T. pendens
B4	Garden Gully, Bendigo	T. fruticosus 4-br.	T. similis T. serra Clonograptus spp.
B5	Hustler's Hill, Bendigo	T. fruticosus 4-br. T. approximatus	D. aureus T. decipiens T. quadribrachiatus T. acclinans Loganograptus logani Clonograptus tenellus

LANCEFIELD SERIES.

L1	Bull Dog Creek Mornington Peninsula	T. approximatus	T. decipiens T. quadribrachiatus T. acclinans C. tenellus
L2	Lancefield, near Deep Creek	Bryograptus victoriae T. decipiens	Clonograptus tenellus
L3	Lancefield Quarry, N.E. of Old Mt. William Railway Station	Dictyonema macgillivrayi B. victoriae	T. decipiens Clonograptus spp. Didymograptus pritchardi D. taylori
L4	North east of Romsey	Dictyonema campanulatum D. scitulum Staurograptus diffissus	No associates have been found
L5	Not yet recognised in Victoria	(Dictyonema)	

In the Castlemaine Series large and variant forms of *D. caduceus* predominate in C1 and give the zone its character. In C2 *D. caduceus* is characteristic, and comprises 80% of the assemblages. C3 is separated from C4 by the relative abundance of *Phyllograptus* associated with *D. caduceus* (T. S. Hall). C3 and C4 are separated by the "absence of *D. bifidus* and the comparative rarity of *D. caduceus*" (T. S. Hall). This is not an important distinction as far as zones C3 and C4 are concerned since *D. caduceus* is not common in some C5 beds. Zones C3 and C4 have often to be grouped as Middle Castlemaine. They are well developed in the Castlemaine district and elsewhere, but thick beds of blue-black slate of favourable appearance yield comparatively few species or even individuals, an interesting contrast with the higher beds, whose richness is largely due to the rapid deployment of *D. caduceus*.

IV.—Correlation of Victorian Zones with those of the Northern Hemisphere.

The examination of Victorian graptolites and their occurrence in the field leads us to the conclusion that, while there is a general resemblance to the succession of the Old World, there are significant differences. Through this resemblance, too, may be seen minor modifications due to the distance apart of the respective provinces.

In making a tentative correlation we have relied largely on the following works; for British Graptolites, Elles and Wood (2), and Elles (3); and for North American Graptolites, Ruedemann (16 and 17).

Lower Ordovician graptolites are found in Victoria in slates alternating with sandstones (there are no limestones or coarse sediments) showing an unusual uniformity in the conditions of sedimentation. The rapidity of the alternation gives a regular succession of more or less complete faunules that go to make up the zones. Compared with it, any other succession with which we are acquainted appears to be incomplete. This apparent incompleteness and the lack of a first-hand knowledge of overseas stratigraphy makes correlation difficult. Although we have used this zonal succession for a considerable period we are presenting it for the first time, and hope that the information embodied in it may induce oversea workers to enter on correlations from their own viewpoints. To bring out the significant differences as well as the general resemblances we venture to correlate the faunas from two standpoints, viz.:

(1) Their essential Lower Ordovician elements, the Dichograptidae.

(2) Their adventitious Upper Ordovician element, predominantly the Axonophora.

Before this can be done it is necessary to decide roughly the equivalence of the Old World and Victorian beds, but the separation of the forms into the two diverse elements makes this easier than it appears at first sight. Roughly, the British zones 1, 2 and 3 appear to represent, incompletely, the Lancefield beds. Zones 4, 5, 6, and 7, without any exact equivalence, may be placed under the Upper Bendigo and Lower Castlemaine, while the next highest British zones do not agree with any Victorian beds lower than the Upper Ordovician. Any further discussion will be valuable or otherwise according to the opinion formed as to the permissibility of this correlation, which has been arrived at after a careful balancing of resemblances and differences.

Accepting it, it will be noticed that a majority of the common forms appear first in the Victorian succession in an association which is regarded as stratigraphically below the British occurrence, and practically all disappear later in Victoria than in Britain. The ranges of the common Dichograptidae appear to show,

then, that the range as illustrated in Britain is but a portion of the maximum range. Where conditions appear to have been favourable, the phylogenetic stages of forms appear to be more characteristically developed in one province or the other. For example, the dependent Didymograpti are much more strongly developed in Britain than in Victoria. There they are well exemplified by a number of species, but in Victoria and New Zealand there seem to be only two species and a number of merging varieties considered unworthy of distinction. This is a striking difference when the apparently extended range of dependent forms in South America is considered (1). On the other hand the phylogeny of the reclined Didymograpti (*D. caduceus=gibberulus*) is represented in Victoria by a number of readily recognised and progressive species developed from a small form which first appears in the Lower Castlemaine beds (C5). Some of the anagenetic forms appear in British zones 4 and 5, but the acmic and paracmic forms do not, as far as we know, occur in Britain at all.

Evidence in support of our correlation is suggested by:—

(a) *Tetragraptus fruticosus.* This form, as figured in the Monograph of British Graptolites (2, Pt. 1) is, in Victoria, a catagenetic phase such as occurs in the upper portion of the Bendigo beds associated with dependent Didymograpti. Even allowing that this stage may have been reached earlier in Britain, there seems little doubt that the stages represented in our lower Bendigo beds do not occur there.

(b) The elaboration of the dependent Didymograpti. These forms, as we have already mentioned, are much more fully developed in Britain than in Victoria. In both provinces their elaboration follows the disappearance of *T. fruticosus.* British zones 6-7 may therefore be well regarded as corresponding approximately to the Victorian zones C5-4, and perhaps including B1. It is questionable, however, whether very much reliance should be placed on a series like this, which, contrary to experience with most other groups, seems to be pauperized in Victoria.

(c) *D. caduceus.* This form, enormously better developed in Victoria than in Britain, does not occur here with *T. fruticosus.* However, its acmic and paracmic forms seem to be missing in Britain, and this suggests the absence there of graptolite shales from the beds at least corresponding to the Victorian Upper Castlemaine and Darriwil.

The correlation of the adventitious Upper Ordovician element must be made on genera, since few species are common to each province. The Dichograptidae, so poorly represented in the Upper Ordovician, have been taken as typically Lower Ordovician, and the Axonophora, although including genera restricted to the Lower Ordovician (e.g. *Trigonograptus*), are by common consent regarded as characteristic of the Upper beds of the Ordovician (16).

TABLE A

Correlation of species of Dichograptidae common to Great Britain and Victoria

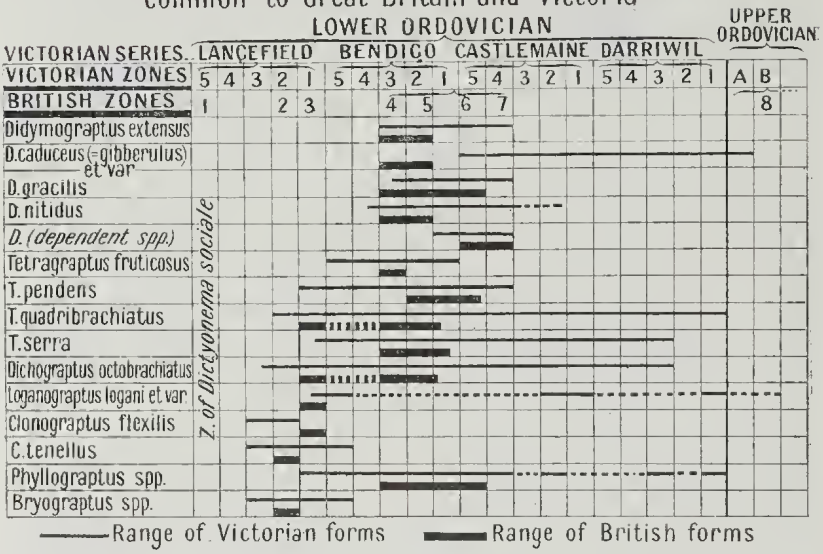
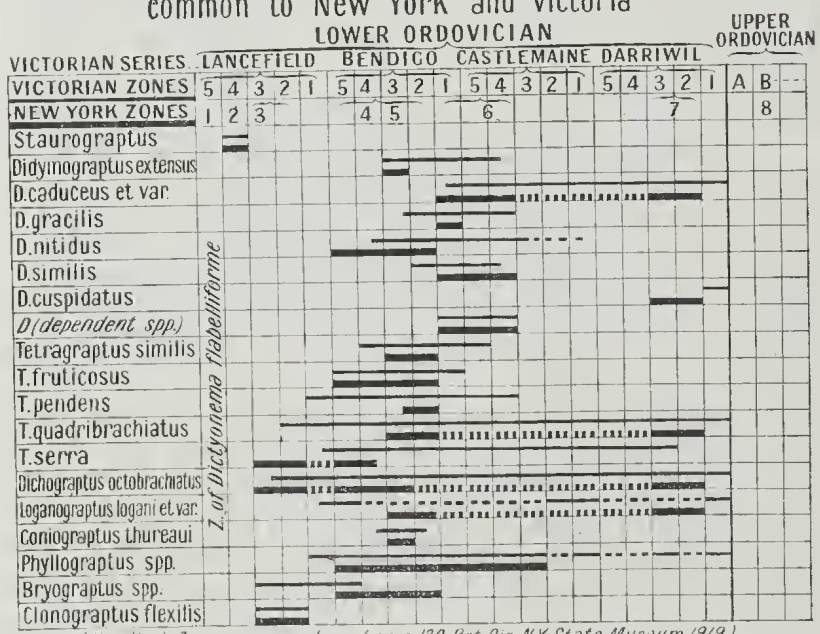


TABLE B

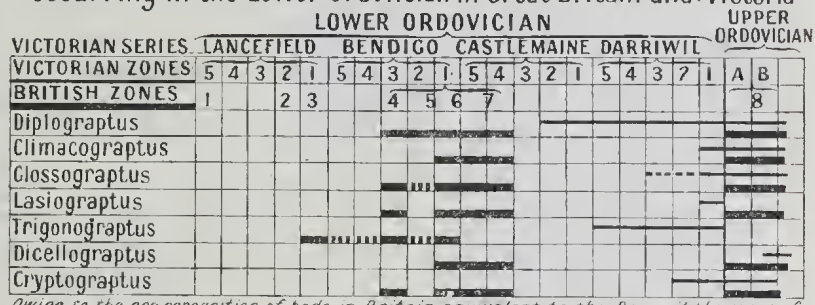
Correlation of species of Dichograptidae common to New York and Victoria



(New York Zones as numbered on p. 130 Rpt. Dir. N.Y. State Museum 1919.)

TABLE C

Correlation of Upper Ordovician Genera occurring in the Lower Ordovician in Great Britain and Victoria

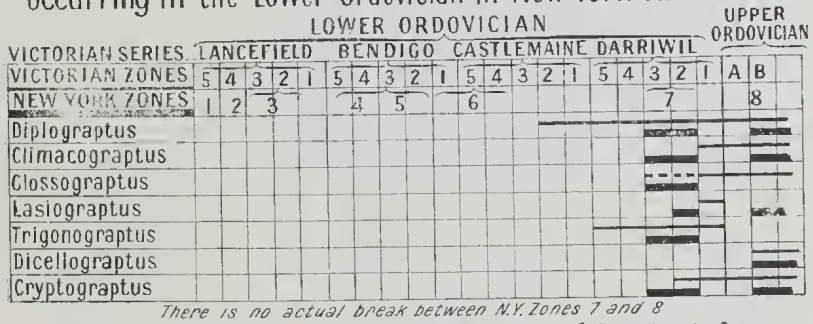


Owing to the non-recognition of beds in Britain equivalent to the Darriwil, the range of the genera in Britain appears broken. This is not really the case between Zones 7 and 8.

——Range of Victorian forms ▬▬ Range of British forms

TABLE D

Correlation of Upper Ordovician Genera occurring in the Lower Ordovician in New York and Victoria



There is no actual break between N.Y. Zones 7 and 8

——Range of Victorian forms ▬▬ Range of New York forms

The outstanding feature of this correlation is that the Upper Ordovician element appears in the British succession before it does in Australia or North America. The American correlation is based on too meagre evidence to enable definite conclusions to be drawn. There appears to be, according to our correlation, too great a gap between zones 6 and 7, which is supported by Ruedemann's statement (16) that at the Deep Kill Beds 6 and 7 (zone 7, zone of *D. dentatus*) are separated by an interval of several hundred feet of non-exposure from the zone of *D. bifidus,* and his note on the profound change between the successive graptolite faunas due to the suppression of the Dichograptidae and the unheralded appearance of the axonophorous Diplograptidae with the genera *Diplograptus, Glossograptus, Trigonograptus, Climacograptus,* and *Retiograptus.*

This break is minimized by the intercalation of the "Ashgill Quarry shales," which have much in common with our upper Darriwil beds. *Tetragraptus quadribrachiatus, D. forcipiformis, D. cuspidatus, Trigonograptus ensiformis,* are common to both hemispheres, while the following American forms have Victorian allies: *P. angustifolius* is allied to *P. nobilis, P. dentatus* to *D. austrodentatus. Glossograptus hystrix* to *G.* sp. nov., *Climacograptus pungens* to *Cl.* cf. *exiguus, Didymograptus filiformis* to *D.* sp. nov., and *D. spinosus* to *D. nodosus.*

Summarizing these Correlations it would appear:—

1. That the successions of Victoria, Britain, and North America approximately agree in so far as they may be correlated on their essential Lower Ordovician element, the Dichograptidae.
2. That in the Victorian sedimentation, zones are preserved which are missing from the records of the British and North American provinces. These "lost zones" leave much to be desired in the way of direct evidence for correlation, but the phylogeny of some of the common species as interpreted by us in Australia indirectly confirms the suggested correlation.
3. The outstanding difference between the British and the Victorian and North American successions is that the Upper Ordovician element appears earlier in Britain than in either Victoria or North America.

In conclusion it is only fair to repeat that the authors are very conscious of the shortcomings of this attempt at correlation. One great drawback is the lack of adequate data. The idea would be for a worker to revise the correlation with the advantage of a personal acquaintance with the "characteristic assemblages" of each province. In the present case the mere occurrence of forms has been made the main basis of correlation, yet the records show provincial differences. Thus *T. fruticosus* seems to be so very poorly represented in Britain that it is not included in a characteristic assemblage of any zone (3), while its development in North America is comparable to its development in Victoria. The tuning fork graptolites, so well developed in Britain, are represented by only two species in both New York and Victoria, and yet are strongly developed in South America. What weight in any attempt at correlation should be placed on points such as these must be left for future discussion.

Description of Species.

The species described and figured in the following pages are for the most part Darriwil forms which are important for zonal purposes.

Diplograptus austrodentatus, sp. nov., is a *Diplograptus* allied to *D. dentatus,* and is the zonal fossil of the D2 beds. *Phyllograptus nobilis,* sp. nov., is the first species of *Phyllograptus* to be

recorded with certainty in Victoria, and is characteristic of the D1 zone. Hitherto most of the Phyllograpti have been recorded as showing affinities to *P. typus* or *P. angustifolius*. *Didymograptus forcipiformis* Ruedemann, a late mutation of *D. caduceus*, although often recorded, has not hitherto been figured among Victorian specimens. *Brachiograptus etaformis*, gen. et. sp. nov., is a multiramous form which does not seem to us to fit into any known genus. It is also a D1 form.

Two Castlemaine forms of special interest are described. *Goniograptus palmatus*, sp. nov., is notable for its extensive disc membrane, while *Didymograptus dependulus*, sp. nov., adds another species to the Victorian tuning fork graptolites, till now represented only by *Didymograptus bifidus*.

The forms dealt with are:—

Diplograptus austrodentatus, sp. nov.
Phyllograptus nobilis, sp. nov.
Didymograptus forcipiformis Ruedemann.
Brachiograptus, gen. nov., *B. etaformis*, sp. nov.
Goniograptus palmatus, sp. nov.
Didymograptus dependulus, sp. nov.

Diplograptus (Glyptograptus) austrodentatus, sp. nov.

(Pl. V, Figs. 4, 5.)

Description.—Polypary short, with an average length of about 10 mm.; subquadrate at the base where it is 1·5 mm. broad, increasing to a width of 2 mm. at the 12th theca. Sicula about 1 mm. wide, with a comparatively short virgella.

Figs. 1—4.

Fig. 1.—Sicula and initial thecae. Spec. 6493A. × 4.
Fig. 2.—Polypary, showing proximal spine. Spec. 31365 (1). × 4 (approx.).
Fig. 3.—Complete polypary. Cotype. The virgella and virgula are shown but no proximal spine. Spec. 3165 (2). × 4.
Fig. 4.—Polypary showing excavations. Spec. Sd.6. × 4.

Thecae 12-14 in 10 mm., 1·5 mm long and 0·5 mm. wide, overlapping half to two-thirds their length, impressed below and with thickened apertural margins, which are normal to the axis of the

polypary in the proximal portion and to the axis of the thecae in the distal portion. The proximal thecae are furnished with both sub-apertural and inconspicuous mesial spines.

Remarks.—The sicula appears to be about 0·4 mm. wide; like the thecae it has a thickened apertural margin. Th 1 (1) arises near the aperture of the sicula, and grows outwards and upwards. Th 1 (2) also grows outwards, presumably from Th 1 (1). The inconspicuous mesial spines are given off where the thecae change direction. These, however, are often absent.

The aspect of the polypary depends wholly on the angle of compression. In the normal bi-profile view the ventral margins of the thecae are straight or slightly sigmoidal. Although they are impressed below no excavation is visible (Pl. V, Fig. 4). In any other mode of compression, either in the obverse or reverse aspect, the impression of the thecae and their thickened apertures facilitate introtorsion and introversion. The proximal portion of the polypary then exhibits excavations occupying one-fourth the width of the polypary and a small fraction of the ventral margin of the thecae (Fig. 3). The distal thecae are more or less introtorted, making oblique excavations occupying one-third the width of the polypary and one-fourth the ventral margin of the thecae (Pl. V, Fig. 4). Thecae showing the characteristics of Climacograptus occasionally occur, but the polypary is more typically Diplograptus than is *D. dentatus*.

The periderm seems to have been moderately thick, and the septum is usually invisible; in some specimens, however, it may be traced at intervals through the polypary.

A photograph (Pl. V, Fig. 4) shows the apertural spines from the medial thecae. There is a suggestion of fine apertural spines in some specimens, while in others they are not seen.

Diplograptus austrodentatus is characterised by its:—

(a) squatness.
(b) sub-quadrate proximal end.
(c) short virgella and sub-apertural and inconspicuous mesial spines on the proximal thecae.
(d) thecal characteristics of a compromise between normality and introtorsion, brought about by impression and apertural thickening relative to the angle of compression.

Affinities.—There seems little doubt that *D. austrodentatus* is closely related to *D. dentatus*. The origin of the initial thecae from the sicula and the peculiar disposition of the spines are suggestive of *D. dentatus*. *D. austrodentatus* was probably less concavo-convex, a feature which made for its compression as a more typical Diplograptus. Its virgella, and usually its virgula, are much less conspicuous, and the number of its thecae in a given length is more constant. The apertural thickening is characteristic of *D. perexcavatus*, of which the obverse aspect as a whole bears many resemblances to the present species. *D. austroden-*

tatus may, however, be regarded as the Australian equivalent of *D. dentatus,* which has not been revealed here in comprehensive collecting over a number of years. Dr. Hall in unpublished identifications referred to this form as *D.* cf. *inutilis,* but examination shows that the two species are quite unlike in thecal characters.

Horizon.—*D. austrodentatus* is the D2 Zone fossil of the Darriwil, though with a range somewhat above and below this zone.

Associates.—In zone D2, *D. austrodentatus* often crowds the beds to the almost entire exclusion of other species, the mature forms being associated with juvenile forms (Fig. 1) in all stages of growth. Its associates in this zone are therefore usually few, but *D. caduceus, Trigonograptus, Cryptograptus, Glossograptus, Lasiograptus, T. serra* and *T. quadribrachiatus* are recorded as associated. When found in higher or lower beds its associates are naturally the forms noted as occurring on those horizons.

Localities.—Steiglitz, Lancefield North, Brisbane Ranges, Bendigo East, Bacchus Marsh, Woodend, Guildford, Bullengarook (Jackson's Creek), Muckleford, etc.

Phyllograptus nobilis, sp. nov.

(Pl. VI, Figs. 3, 4.)

Description.—Stipes united to form the characteristic phyllograptus polypary, with elongate-ovate, broad oval, or obovate outline. Thecae 11 in 10 mm., direction of curvature varied, but with ventral margins, when clearly seen, sigmoidal. In contact for not quite the full length, apertural margins concave, mucronate with distinct denticle.

Remarks.—This species approaches closely both *P. typus* and *P. angustifolius.* It is distinguished from both by the sigmoid curvature of the thecal walls and the nature of the aperture. Both these characters are strongly reminiscent of *Didymograptus caduceus, Oncograptus* and *Cardiograptus,* a fact probably of genetic importance. Owing to the sigmoid curvature of the thecal walls slightly magnified specimens often appear as if in relief.

Although *Phyllograptus* in Victoria ranges from at least the lower Bendigo beds to the upper middle Castlemaine, it has not yet been recorded from the Upper Castlemaine (C1) nor from more than one C2 locality. It reappears in the Darriwil, and though its occurrence there is rather sporadic (Dr. Hall does not record it from these beds at Steiglitz) it seems to range right through the series. Collections have been made from all horizons, but no detailed examination of the genus has yet been made, chiefly because the state of preservation is not sufficiently good. Our own observations lead us to the conclusion that the Darriwil and lower Phyllograpti are almost certainly specifically distinct, the forms from the lower beds being separable only with difficulty from *P. typus.* Whether more than one other species occurs in

the Darriwil series must be left for later determination. It may be mentioned that *Phyllograptus* has been recorded in New Zealand from beds equivalent to our C1. The polyphylogenetic origin of the genus is a possibility which needs consideration in any comprehensive treatment.

Localities and Horizon.—The type specimens are from the D1 (Upper Darriwil) belt of Bendigo East. Undoubted examples have also been obtained lately by Harris and Thomas from the Gibbo River, in north-eastern Victoria. The associated forms are in each case *Diplograptus* and *Climacograptus*, and in the Bendigo East localities, the whole D1 assemblage.

Didymograptus forcipiformis Ruedemann.

(Pl. VI, Figs. 6, 7.)

1904 *Didymograptus forcipiformis* Ruedemann, Grap. New York, Pt. I.

Description.—Nema filamentous, extremely thin. Sicula long and slender. Two branches bent at their base to such a degree that their distal parts, which are straight, become sub-parallel. Angle of divergence 350° or more. Branches rarely exceeding 10 mm. in length and tapering distally. Thecae long, but becoming shorter in the distal portion where the angle of inclination becomes less than 45°. 11-12 in 10 mm., curved, about twice as long as wide, in contact throughout their length. Apertural margins concave; thecae with the pronounced mucros of *Didymograptus caduceus.*

Remarks.—The above description is based on Ruedemann (*supra cit.*), who points out that *D. forcipiformis* is a late derivative of *D. caduceus.* The differences he mentions are:—

(1) greater divergence of branches.
(2) smaller width of the distal parts of branches.
(3) great width of proximal part.
(4) less close arrangement of thecae.
(5) presence of apertural mucros or spines.

The first three differences can be seen in our specimens, but the thecae of our forms are not more closely arranged than in many forms of *D. caduceus*, which is also a mucronate form.

Like its antecedent *D. caduceus, D. forcipiformis* is extremely common at certain outcrops, along with other mutations of *D. caduceus*, such as var. *manubriatus. D. caduceus* Salter var. *nanus* Rued. seems to fall between *D. caduceus* Salter var. *manubriatus* T. S. Hall and *D. forcipiformis.*

Horizon and Localities.—Dr. Hall (10) records *D. forcipiformis* in Darriwil associations from the Woodend-Macedon and Steiglitz districts. Harris (12) records it from the Castlemaine district. It occurs often in large numbers in the lower Darriwil beds, D5, and ranges through the Darriwil series. To the localities given above may be added Gisborne and Bendigo East.

Associates.—The associates of this form are those of the zone of the Darriwil in which it occurs, and are set out elsewhere in this paper.

Brachiograptus, gen. nov.

(Pl. VI, Figs. 8, 9.)

Description.—Polypary bilaterally symmetrical. The first two thecae which arise from the sicula comprise the funicle, which is slightly declined, though straight as compressed. Each of these thecae gives rise to two thecae, constituting the branches of the second order, which diverge at an angle of from 105° to 130°. The later development may be expressed in terms of (a) lateral branching, or (b) dichotomous branching.

(a) Each of the branches of the second order develops at right angles to the funicle, forming a characteristic H; and lateral branches up to 16 or more and remaining undivided, grow outwards from the successive thecae forming the H.

(b) The branches of the second order bifurcate giving rise to a terminal branch, which grows outwards, and a stolonal theca at right angles to the funicle. Dichotomy may be so repeated until there are up to 16 or more terminal branches growing outwards from the characteristic H formed by the stolonal thecae.

Remarks.—While the branching of graptolites is, as at present, used as a character of generic value, the erection of a new genus for such forms is, in our opinion, necessary. This decision is made after a careful consideration of the opinions of previous workers, which have recently been summed up by Bulman (1, pp. 23-5). Bulman accepts as of generic importance "the significant distinction which was rather to be found in the varying capacity of the genera for dichotomy," in this following Dr. Elles. He notes in a South American form, but does not consider as of more than varietal importance, the limitation of the power of dichotomy to the "inner" third order stipes. In our form it does not appear that this is a stage in the reduction of stipes, as Bulman appears to consider it, since 16-branched forms commonly occur, and even more branches may be developed. We do not wish to raise the question as to whether the branch development is the result of the dichotomy or of unilateral branching, as at present there seems no test which will separate the results of either method, but if limitation of dichotomy is of systematic value, the very definite limitation as shown in this case is as important as that on which the genera of Dichograptus and Loganograptus are founded. We may add that the whole matter of these multiramous forms is in an unsatisfactory state, since the thecal characters which are almost certainly of at least as great systematic value as nature of branching are neglected altogether. Under both of these genera, forms which differ greatly in thecal characters are separated only as varieties. This is the case, for

example, with *Loganograptus logani* J. Hall, var. *boliviensis* Bulman. The long tubular thecae are quite unlike those of *Loganograptus logani, forma typica,* so also the variety of *Dichograptus octobrachiatus* figured on the same page (1, Pl. 1).

Brachiograptus etaformis, gen. et sp. nov.

(Pl. VI, Figs. 8, 9.)

Description.—Sicula small, slender, not always visible, but of an observed length of 1 mm. First theca budding aperturally, this and the second forming the funicle, which is probably declined, though in compressed specimens it is often straight; these thecae narrow, tubular, and long (1 mm.). Branches of the second order arising by dichotomy and diverging at angles of from 105° to 130°. From near the aperture of each successive theca on the outer side of the H later branches are given off which divide the outer 180° more or less evenly. There are usually three of these tertiary branches from each secondary branch, making a 16-branched polypary, but the number may be less, or, occasionally, an extra branch may be developed. Thecae long (0·9 mm.), slender, tubular, and slightly concavo-convex, especially on the secondary branches, overlap slight, 8-10 in 10 mm., apertural margins normal to axis. The tertiary branches do not subdivide.

This description, based on the assumption that the branching is unilateral, can be easily adapted to express the same result by successive dichotomy.

Remarks.—The relation of this form to *Loganograptus* has been touched on in the description of the genus. The arrangement of branches seems to be conditioned by food supply, and lateral branching solves the problem of an equal distribution of the thecae on a plan different from that adopted by *Loganograptus*. The difference in mode of branching, the characteristic outline of the polypary resulting from this, the different type of thecae, and the development of branches from successive thecae, all serve to distinguish the present species from *Loganograptus logani*, the only species it resembles even superficially. It is, moreover, a much less robust form, and polyparies are common which appear to have been stripped of their thecae. Its closest relations are with *Loganograptus logani* var. *boliviensis* Bulman var., which as we have already stated is, according to our interpretation, best regarded as an allied species of *Brachiograptus*.

Horizon and Localities.—*Brachiograptus etaformis* is very common at many Upper Darriwil (D1) localities, particularly on the McIvor Road (Bendigo East), and south-east of Strathfieldsaye in the same belt. It also is found in beds on about the same horizon at Guildford, Woodend, Gisborne, and near Romsey. Its associates are the common D1 assemblage. (Tabulation of Zones, p. 31).

GONIOGRAPTUS PALMATUS, sp. nov.

(Pl. VI, Fig. 5.)

Description.—From the sicula which has not been observed, two thecae arise, forming the funicle which is straight and 4 mm. in length. By dichotomy two short branches of the second order arise from each end of the funicle, the angles between them being 85° and 105° in the type specimen. From the angles of these branches other branches arise alternately from each side, till a 16-branched form is produced. The angle included between all but the most distal branches varies from 40° to 80°, the angle between the two last branches in each of the four main stems being less than this.

5.

Text Fig. 5.

Fig. 5.—Distal thecae. Type Spec. Xc.4.

The thecae are long and narrow, with little overlap, only 6-7 in 10 mm. with concave ventral walls, inclined to the axis of the stipe at a low angle. Apertural margins often apparently convex, though this appearance may be due to the delicacy of the apertural walls except along the ventral margin. A feature of the type specimen is the disc, which not only "clasps the funicle and principal branches to the base of the terminal denticulate branches," as described in Ruedemann's account of *Goniograptus thureaui* (16), but extends as a web on each side of the funicle and between each pair of branches. At its widest it spans a distance of 5 mm., with a catenary curve. In spite of its prominence on the type specimen it would probably be unsafe to predict that it would always be present.

Remarks.—The type specimen is preserved on two slabs, one showing the funicle and three of the four main branches, the other, part of the reverse slab, showing the funicle and the fourth branch. From the two the figure (Pl. VI, Fig. 5) has been restored. The general appearance of the form is quite distinctive. Its thecae resemble those of *Goniograptus geometricus* Rued. and *G. perflexilis* Rued. From *G. geometricus* the less definite angular junctions distinguish it, while it is an altogether more robust form than *G. perflexilis*.

Horizon and Locality.—Middle Castlemaine (C4), Campbell's Creek (Castlemaine).

Associated Forms.—On the same slab occur *Didymograptus* cf. *extensus, Dichograptus* cf. *octonarius, Tetragraptus similis* and *T. serra. Phyllograptus, Clonograptus* and *Triacnograptus neglectus* were also found at the same outcrop.

DIDYMOGRAPTUS DEPENDULUS, sp. nov.

(Pl. VI, Figs. 1, 2.)

Description.—Stipes robust, about 1·5 cms. long, expanding gradually to a width of rather more than 1 mm., and then narrowing towards the distal extremity; diverging from a large sicula at an angle of about 90°, and then gradually approaching till they lie at an angle of about 45°. Thecae 10-11 in 10 mm., about twice as long as wide, inclined to the axis of the stipe, but at a lower angle in the distal portion. The apertural angle varies according to the mode of preservation from distinctly concave to convex, the latter appearance being due perhaps to fracture of the apertural edge. The sicula is usually provided with a conspicuous nema, which may be 5 mm. or more long.

Remarks.—This very characteristic tuning fork Didymograptus cannot be confused with any other species with which we are acquainted, and, seeing that it is present in some of the older collections of the Geological Survey, it is remarkable that it so long escaped notice. It is not closely related to the other Victorian dependent *Didymograptus, D. bifidus;* it appears to have more affinity with *Tetragraptus fruticosus* than any other Victorian form with which we are acquainted.

Horizon and Localities.—Middle Castlemaine (C4)—the bed above that characterized by *D. bifidus*. So far this form has been found only at a few localities, near Quartz Hill (Castlemaine), by the Geological Survey and Harris, south of Axedale by Caldwell and Harris, and at Steiglitz by W. H. Ferguson. The Steiglitz forms are in a collection examined by Dr. Hall, but no note of them appears in the published report. From the labels on them in Dr. Hall's handwriting, we conclude that he put them aside for later examination.

Associated Forms.—As stated elsewhere, the C4 beds are not rich in graptolites as a rule. *D. caduceus* (small), *Tetragraptus serra* and *Phyllograptus* cf. *typus,* are perhaps the commonest associates.

VI.—Acknowledgments.

We desire to acknowledge our indebtedness to Mr. C. W. Brazenor, of the National Museum, who is responsible for the photographic illustrations of the zonal species in the plates. His effort will appeal to those who are acquainted with the difficulties of graptolite illustration.

To the Director of the Geological Survey and his draughting staff we are indebted for the legible presentation of the Correlation Tables.

VII.—Bibliography.

1. BULMAN, O. M. B., 1931. South American Graptolites, Arkiv f. Zoologi K.Sv.V.22 A.3.
2. ELLES, G. L., and WOOD, E. M. R., 1901-13. A Monograph of British Graptolites, Palaeontographical Society, Part I-X.

3. Elles, G. L., 1925. The Characteristic Assemblages of the Graptolite Zones of the British Isles. *Geol. Mag.*, lxii, Aug. 1925, pp. 337-347.
4. Ferguson, W. H., 1921. Lower Ordovician Rocks near Boolara. *Rec. Geol. Surv. Vic.*, iv, (3), pp. 275.
5. Hall, T. S., 1894. Geology of Castlemaine. *Proc. Roy. Soc. Vic.* (n.s.), viii.
6. Hall, T. S., 1899. Graptolite Bearing Rocks of Victoria, Australia, *Geol. Mag.* Decade IV, vi, pp. 438-451.
7. Hall, T. S., 1909. Recent Advances in our Knowledge of Victorian Graptolites. *Aust. Assoc. Advct. Sci.* Brisbane Meeting.
8. Hall, T. S., 1912. Reports on Graptolites. *Rec. Geol. Surv. Vic.* iii, (2).
9. Hall, T. S., 1914. Victorian Graptolites. *Brit. Assoc. Advct. Sci.* Melbourne Meeting.
10. Hall, T. S., 1914. Victorian Graptolites, Part 4, *Proc. Roy. Soc. Vic.* xxvii, (n.s.), (1).
11. Hall, T. S., 1914. Reports on Graptolites No. 11. *Rec. Geol. Surv. Vic.* iii, (3), pp. 290-292.
12. Harris, W. J., 1916. The Palaeontological Sequence at the Lower Ordovician Rocks in the Castlemaine District. *Proc. Roy. Soc. Vic.* xxix, (n.s.), (1), pp. 50-74.
13. Harris, W. J., and Crawford, W., 1921. Sedimentary Rocks of the Gisborne District. *Ibid.* xxxiii (n.s.).
14. Harris, W. J., and Keble, R. A., 1928. The Staurograptus Beds of Victoria. *Ibid.* xl (2).
15. Hart, T. S., 1908. Graptolite Beds at Daylesford. *Ibid.* xxi (n.s.), (1).
16. Ruedemann, R., 1904. Graptolites of New York, Part I. *New York State Museum*, Mem. 7.
17. Ruedemann, R., 1919. Graptolite Zones of the Ordovician Shale Belt of New York. *16th Ann. Rept. New York State Museum*, pp. 116-130.

Description of Plates III-VI.

Plate III.

Dictyonema macgillivrayi, T. S. Hall. Quarry Allot. 56, Parish of Goldie. Nat. Mus. No. 13126. (Figd. in part *Proc. Roy. Soc. Vic.* iv (1892), pl. ii, fig. 2. Photo. × 1½.

Plate IV.

Fig 1.—*Tetragraptus fruticosus* (J. Hall). 4-branched form. Sailors Creek, Daylesford. Nat. Mus. No. 51. Photo × 2.

Fig. 2.—*Bryograptus victoriae* T. S. Hall. Quarry, Allot. 56, Parish of Goldie. Nat. Mus. No. 237. Photo. × 1½.

Fig. 3.—*Cardiograptus morsus* Harris and Keble. Shicer Gully, between Guildford and Rocky Water Holes. Nat. Mus. No. 13083. Geol. Surv. Q.S. 15 SE. Ba 91. Photo. × 1½.

Fig. 4.—*T. approximatus* Nich. Allot. 16A. Parish of Campbelltown. Nat. Mus. No. 13094. Photo. × 1½.

Fig. 5.—*T. fruticosus* (J. Hall). 3-branched form. South New Moon Mine, Eaglehawk, Geol. Surv. Vic. Photo. × 1½.

Fig. 6.—*Didymograptus bifidus* (J. Hall). East of Guildford. Nat. Mus. No. 25, Geol. Surv. Q.S. 15, SE, Ba 93. Photo. × 2⅔.

Fig. 7.—*Phyllograptus* sp. Bendigo. No. 9755. Geol. Surv. Vict. Loc. 79 BO. Photo. × 1½.

Fig 8.—*Oncograptus upsilon* T. S. Hall. Campbell's Creek, N.W. of Yapeen. Nat. Mus. No. 13071. Geol. Surv. Q.S. 15 NE, Ba 90, Photo × 1½.

Fig. 9.—*D. caduceus* Salter. Sub-maximum development, Barker's Creek, Castlemaine. W. J. Harris Coll. Photo. × 1½.
Fig. 10.—*D. caduceus* Salter. Small form. Steiglitz. No. 6287, Geol. Surv. Vict. Loc. 26, ZS. Photo. × 1½.
Fig. 11.—*D. caduceus* Salter. Maximum development. McKenzie's Hill, Castlemaine. W. J. Harris Coll. Photo. × 1½.

PLATE V.

Fig. 1.—*Staurograptus diffissus* Harris and Keble. Stauro Gully, N 18° W from SW corner of Allot. 26, Parish of Springfield, on water reserve. Nat. Mus. No. 13639. Photo. × 7.
Fig. 2.—*Didymograptus nodosus* Harris. Bendigo East, W. J. Harris Coll. No. 77. Photo. × 2.
Fig. 3.—*Loganograptus* cf. *logani* (J. Hall). Sutherland Creek, Parish of Darriwil. Nat. Mus. No. 89. Geol. Surv. Q.S. WL S1. Photo. × 1½.
Fig. 4.—*Diplograptus austrodentatus*, sp. nov. Cotype. Geol. Surv. Vict. No. 31328 Loc. WL/34, Allot. 74, Parish of Lancefield. Photo. × 8.
Fig. 5.—*D. austrodentatus*, sp. nov. Steiglitz. No. 7475. Geol. Surv. Vict. Loc. 7 Sz. Drawing × 6 (approx.).

PLATE VI.

Fig. 1.—*Didymograptus dependulus*, sp. nov. Holotype, Steiglitz. No. 6290. Geol. Surv. Vict. Loc. 26, Sz. Drawing × 1½.
Fig. 2.—*D. dependulus*, sp. nov. Paratype. Quartz Hill, Castlemaine. No. 29625. Geol. Surv. Vict. Loc. 54. Drawing × 1½.
Fig. 3.—*Phyllograptus nobilis*, sp. nov. Group including holotype type Strathfieldsaye, Bendigo East. W. J. Harris Coll. S3A. Drawing × 1½.
Fig. 4.—*P. nobilis*, sp. nov. Holotype. Strathfieldsaye, Bendigo East. W. J. Harris Coll. S3A. Drawing × 1½.
Fig. 5.—*Goniograptus palmatus*, sp. nov. (1). Campbell's Creek, Castlemaine. W. J. Harris Coll. X02 and X02 Cotypes. Drawing × 1¾.
Fig. 6.—*Didymograptus forcipiformis* Ruedemann. Waterloo Flat, Gisborne. W. J. Harris Coll. XO. Drawing × 1½.
Fig. 7.—*D. forcipiformis* Ruedemann. Waterloo Flat, Gisborne. W. J. Harris Coll. XP. Drawing × 1½.
Fig. 8.—*Brachiograptus etaformis*, gen. et sp. nov. Strathfieldsaye, Bendigo East. Paratype. W. J. Harris Coll. S3K. Drawing × 1½.
Fig. 9.—*B. etaformis*, gen. et sp. nov. Holotype. Strathfieldsaye, Bendigo East. W. J. Harris Coll. S3, 100. Drawing × 1½